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Forrest et al.

[11] **Patent Number:** **5,757,026**[45] **Date of Patent:** **May 26, 1998**[54] **MULTICOLOR ORGANIC LIGHT EMITTING DEVICES**

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[51] **Int. Cl.⁶** **H01L 33/00**[52] **U.S. Cl.** **257/40**; 257/88; 257/89; 257/90; 257/91; 257/92; 257/93; 257/103[58] **Field of Search** 257/89, 90, 88, 257/40, 91, 92, 93, 103**References Cited****U.S. PATENT DOCUMENTS**

3,611,069	10/1971	Galganaitis et al.	.....	317/235 R
3,783,353	1/1974	Pankove	.....	317/235 R
3,840,793	10/1974	Usui	.....	340/378 R
3,875,456	4/1975	Kano et al.	.....	313/501
4,365,260	12/1982	Holonyak, Jr.	.....	357/17
4,577,207	3/1986	Copeland	.....	357/17
4,605,942	8/1986	Camlibel et al.	.....	357/17
4,900,584	2/1990	Tuenge et al.	.....	427/66
5,059,861	10/1991	Littman	.....	313/503
5,075,743	12/1991	Behfar-Rad	.....	357/17
5,077,588	12/1991	Yamada et al.	.....	357/17
5,144,473	9/1992	Gemma et al.	.....	359/270
5,166,761	11/1992	Olson et al.	.....	257/46
5,231,049	7/1993	Neugebauer et al.	.....	437/128
5,294,869	3/1994	Tang et al.	.....	313/504
5,294,870	3/1994	Tang et al.	.....	313/504
5,315,129	5/1994	Forrest et al.	.....	257/21
5,391,896	2/1995	Wanlass	.....	257/80

5,405,710	4/1995	Dodabalapur et al.	.....	428/690
5,409,783	4/1995	Tang et al.	.....	428/690
5,424,560	6/1995	Norman et al.	.....	257/40
5,429,884	7/1995	Namiki et al.	.....	428/690
5,457,565	10/1995	Namiki et al.	.....	359/273
5,478,658	12/1995	Dodabalapur et al.	.....	428/690
5,583,350	12/1996	Norman et al.	.....	257/89 X

FOREIGN PATENT DOCUMENTS

355041707 A 3/1980 Japan 257/88

OTHER PUBLICATIONS

Frescura et al. "Large High-Density Monolithic XY-Addressable Arrays For Flat-Panel LED Panel," *IEEE Transactions on Electron Devices*, vol. ED-24, No. 7, Jul. 1977, pp. 891-898.

(List continued on next page.)

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[57] ABSTRACT

A multicolor organic light emitting device employs vertically stacked layers of double heterostructure devices which are fabricated from organic compounds. The vertical stacked structure is formed on a glass base having a transparent coating of ITO or similar metal to provide a substrate. Deposited on the substrate is the vertical stacked arrangement of three double heterostructure devices, each fabricated from a suitable organic material. Stacking is implemented such that the double heterostructure with the longest wavelength is on the top of the stack. This constitutes the device emitting red light on the top with the device having the shortest wavelength, namely, the device emitting blue light, on the bottom of the stack. Located between the red and blue device structures is the green device structure. The devices are configured as stacked to provide a staircase profile whereby each device is separated from the other by a thin transparent conductive contact layer to enable light emanating from each of the devices to pass through the semitransparent contacts and through the lower device structures while further enabling each of the devices to receive a selective bias.

30 Claims, 18 Drawing Sheets